

A Look at Boiler Installs using the IMC

CHAPTER 10

BOILERS, WATER HEATERS AND PRESSURE VESSELS

SECTION 1001 GENERAL

101.1 Scope. This chapter shall govern the installation, alteration and repair of boilers, water heaters and pressure vessels.

Exceptions:

1. Pressure vessels used for unheated water supply.
2. Portable unfired pressure vessels and Interstate Commerce Commission containers.
3. Containers for bulk oxygen and medical gas.
4. Unfired pressure vessels having a volume of 5 cubic feet (0.14 m³) or less operating at pressures not exceeding 250 pounds per square inch (psi) (1724 kPa) and located within occupancies of Groups B, F, H, M, R, S and U.
5. Pressure vessels used in refrigeration systems that are regulated by Chapter 11 of this code.
6. Pressure tanks used in conjunction with coaxial cables, telephone cables, power cables and other similar humidity control systems.
7. Any boiler or pressure vessel subject to inspection by federal or state inspectors.

SECTION 1002 WATER HEATERS

1002.1 General. Potable water heaters and hot water storage tanks shall be listed and labeled and installed in accordance with the manufacturer's installation instructions, the *International Plumbing Code* and this code. All water heaters shall be capable of being removed without first removing a permanent portion of the building structure. The potable water connections and relief valves for all water heaters shall conform to the requirements of the *International Plumbing Code*. Domestic electric water heaters shall comply with UL 174 or UL 1453. Commercial electric water heaters shall comply with UL 1453. Oil-fired water heaters shall comply with UL 732.

1002.2 Water heaters utilized for space heating. Water heaters utilized both to supply potable hot water and provide hot water for space-heating applications shall be listed and labeled for such applications by the manufacturer and shall be installed in accordance with the manufacturer's installation instructions and the *International Plumbing Code*.

1002.2.1 Sizing. Water heaters utilized for both potable water heating and space-heating applications shall be sized to prevent the space-heating load from diminishing the required potable water-heating capacity.

1002.2.2 Scald protection. Where a combination potable water-heating and space-heating system requires water for

space heating at temperatures higher than 140°F (60°C), a tempering valve shall be provided to temper the water supplied to the potable hot water distribution system to a temperature of 140°F (60°C) or less.

1002.3 Supplemental water-heating devices. Potable water-heating devices that utilize refrigerant-to-water heat exchangers shall be approved and installed in accordance with the *International Plumbing Code* and the manufacturer's installation instructions.

SECTION 1003 PRESSURE VESSELS

1003.1 General. All pressure vessels shall bear the label of an approved agency and shall be installed in accordance with the manufacturer's installation instructions.

1003.2 Piping. All piping materials, fittings, joints, connections and devices associated with systems utilized in conjunction with pressure vessels shall be designed for the specific application and shall be approved.

1003.3 Welding. Welding on pressure vessels shall be performed by approved welders in compliance with nationally recognized standards.

SECTION 1004 BOILERS

1004.1 Standards. Oil-fired boilers and their control systems shall be listed and labeled in accordance with UL 726. Electric boilers and their control systems shall be listed and labeled in accordance with UL 834. Boilers shall be designed and constructed in accordance with the requirements of ASME CSD-1 and as applicable, the *ASME Boiler and Pressure Vessel Code*, Sections I, II, V, and IX; NFPA 8501; NFPA 8502 or NFPA 8504.

1004.2 Installation. In addition to the requirements of this code, the installation of boilers shall conform to the manufacturer's instructions. Operating instructions of a permanent type shall be attached to the boiler. Boilers shall have all controls set, adjusted and tested by the installer. The manufacturer's rating data and the nameplate shall be attached to the boiler.

1004.3 Working clearance. Clearances shall be maintained around boilers, generators, heaters, tanks and related equipment and appliances so as to permit inspection, servicing, repair, replacement and visibility of all gauges. When boilers are installed or replaced, clearance shall be provided to allow access for inspection, maintenance and repair. Passageways around all sides of boilers shall have an unobstructed width of not less than 18 inches (457 mm), unless otherwise approved.

1004.3.1 Top clearance. High-pressure steam boilers having a steam-generating capacity in excess of 5,000 pounds per hour (2268 kg/h) or having a heating surface in excess of 1,000 square feet (93 m²) or input in excess of 5,000,000 Btu/h (1465 kW) shall have a minimum clearance of 7 feet (2134 mm) from the top of the boiler to the ceiling. Steam-heating boilers and hot-water-heating boilers that exceed one of the following limits: 5,000,000 Btu/h input (1465 kW); 5,000 pounds of steam per hour (2268 kg/h) capacity or a 1,000-square-foot (93 m²) heating surface; and high-pressure steam boilers that do not exceed one of the following limits: 5,000,000 Btu/h input (1465 kW); 5,000 pounds of steam per hour (2268 kg/h) capacity or a 1,000-square-foot (93 m²) heating surface; and all boilers with manholes on top of the boiler, shall have a minimum clearance of 3 feet (914 mm) from the top of the boiler to the ceiling. Package boilers, steam-heating boilers and hot-water-heating boilers without manholes on top of the shell and not exceeding one of the limits of this section shall have a minimum clearance of 2 feet (610 mm) from the ceiling.

1004.4 Mounting. Equipment shall be set or mounted on a level base capable of supporting and distributing the weight contained thereon. Boilers, tanks and equipment shall be secured in accordance with the manufacturer's installation instructions.

1004.5 Floors. Boilers shall be mounted on floors of noncombustible construction, unless listed for mounting on combustible flooring.

1004.6 Boiler rooms and enclosures. Boiler rooms and enclosures and access thereto shall comply with the *International Building Code* and Chapter 3 of this code. Boiler rooms shall be equipped with a floor drain or other approved means for disposing of liquid waste.

1004.7 Operating adjustments and instructions. Hot water and steam boilers shall have all operating and safety controls set and operationally tested by the installing contractor. A complete control diagram and boiler operating instructions shall be furnished by the installer for each installation.

SECTION 1005 BOILER CONNECTIONS

1005.1 Valves. Every boiler or modular boiler shall have a shutoff valve in the supply and return piping. For multiple boiler or multiple modular boiler installations, each boiler or modular boiler shall have individual shutoff valves in the supply and return piping.

Exception: Shutoff valves are not required in a system having a single low-pressure steam boiler.

1005.2 Potable water supply. The water supply to all boilers shall be connected in accordance with the *International Plumbing Code*.

SECTION 1006 SAFETY AND PRESSURE RELIEF VALVES AND CONTROLS

1006.1 Safety valves for steam boilers. All steam boilers shall be protected with a safety valve.

1006.2 Safety relief valves for hot water boilers. Hot water boilers shall be protected with a safety relief valve.

1006.3 Pressure relief for pressure vessels. All pressure vessels shall be protected with a pressure relief valve or pressure-limiting device as required by the manufacturer's installation instructions for the pressure vessel.

1006.4 Approval of safety and safety relief valves. Safety and safety relief valves shall be listed and labeled, and shall have a minimum rated capacity for the equipment or appliances served. Safety and safety relief valves shall be set at a maximum of the nameplate pressure rating of the boiler or pressure vessel.

1006.5 Installation. Safety or relief valves shall be installed directly into the safety or relief valve opening on the boiler or pressure vessel. Valves shall not be located on either side of a safety or relief valve connection. The relief valve shall discharge by gravity.

1006.6 Safety and relief valve discharge. Safety and relief valve discharge pipes shall be of rigid pipe that is approved for the temperature of the system. The discharge pipe shall be the same diameter as the safety or relief valve outlet. Safety and relief valves shall not discharge so as to be a hazard, a potential cause of damage or otherwise a nuisance. High-pressure-steam safety valves shall be vented to the outside of the structure. Where a low-pressure safety valve or a relief valve discharges to the drainage system, the installation shall conform to the *International Plumbing Code*.

1006.7 Boiler safety devices. Boilers shall be equipped with controls and limit devices as required by the manufacturer's installation instructions and the conditions of the listing.

1006.8 Electrical requirements. The power supply to the electrical control system shall be from a two-wire branch circuit that has a grounded conductor, or from an isolation transformer with a two-wire secondary. Where an isolation transformer is provided, one conductor of the secondary winding shall be grounded. Control voltage shall not exceed 150 volts nominal, line to line. Control and limit devices shall interrupt the ungrounded side of the circuit. A means of manually disconnecting the control circuit shall be provided and controls shall be arranged so that when deenergized, the burner shall be inoperative. Such disconnecting means shall be capable of being locked in the off position and shall be provided with ready access.

SECTION 1007 BOILER LOW-WATER CUTOFF

1007.1 General. All steam and hot water boilers shall be protected with a low-water cutoff control.

1007.2 Operation. The low-water cutoff shall automatically stop the combustion operation of the appliance when the water level drops below the lowest safe water level as established by the manufacturer.

SECTION 1008 STEAM BLOWOFF VALVE

1008.1 General. Every steam boiler shall be equipped with a quick-opening blowoff valve. The valve shall be installed in the opening provided on the boiler. The minimum size of the valve shall be the size specified by the boiler manufacturer or the size of the boiler blowoff-valve opening.

1008.2 Discharge. Blowoff valves shall discharge to a safe place of disposal. Where discharging to the drainage system, the installation shall conform to the *International Plumbing Code*.

SECTION 1009 HOT WATER BOILER EXPANSION TANK

1009.1 Where required. An expansion tank shall be installed in every hot water system. For multiple boiler installations, a minimum of one expansion tank is required. Expansion tanks shall be of the closed or open type. Tanks shall be rated for the pressure of the hot water system.

1009.2 Closed-type expansion tanks. Closed-type expansion tanks shall be installed in accordance with the manufacturer's instructions. The size of the tank shall be based on the capacity of the hot-water-heating system. The minimum size of the tank shall be determined in accordance with the following equation:

$$V_t = \frac{(0.00041T - 0.0466)V_s}{\left(\frac{P_a}{P_f}\right) - \left(\frac{P_a}{P_o}\right)} \quad (\text{Equation 10-1})$$

For SI:

$$V_t = \frac{(0.000738T - 0.03348)V_s}{\left(\frac{P_a}{P_f}\right) - \left(\frac{P_a}{P_o}\right)}$$

where:

V_t = Minimum volume of tanks (gallons) (L).

V_s = Volume of system, not including expansion tanks (gallons) (L).

T = Average operating temperature (°F) (°C).

P_a = Atmospheric pressure (psi) (kPa).

P_f = Fill pressure (psi) (kPa).

P_o = Maximum operating pressure (psi) (kPa).

1009.3 Open-type expansion tanks. Open-type expansion tanks shall be located a minimum of 4 feet (1219 mm) above the highest heating element. The tank shall be adequately sized for the hot water system. An overflow with a minimum diameter of 1 inch (25 mm) shall be installed at the top of the tank. The overflow shall discharge to the drainage system in accordance with the *International Plumbing Code*.

SECTION 1010 GAUGES

1010.1 Hot water boiler gauges. Every hot water boiler shall have a pressure gauge and a temperature gauge, or a combination pressure and temperature gauge. The gauges shall indicate the temperature and pressure within the normal range of the system's operation.

1010.2 Steam boiler gauges. Every steam boiler shall have a water-gauge glass and a pressure gauge. The pressure gauge shall indicate the pressure within the normal range of the system's operation.

1010.2.1 Water-gauge glass. The gauge glass shall be installed so that the midpoint is at the normal boiler water level.

SECTION 1011 TESTS

1011.1 Tests. Upon completion of the assembly and installation of boilers and pressure vessels, acceptance tests shall be conducted in accordance with the requirements of the ASME *Boiler and Pressure Vessel Code*. Where field assembly of pressure vessels or boilers is required, a copy of the completed U-1 Manufacturer's Data Report required by the ASME *Boiler and Pressure Vessel Code* shall be submitted to the code official.

1011.2 Test gauges. An indicating test gauge shall be connected directly to the boiler or pressure vessel where it is visible to the operator throughout the duration of the test. The pressure gauge scale shall be graduated over a range of not less than one and one-half times and not greater than four times the maximum test pressure. All gauges utilized for testing shall be calibrated and certified by the test operator.

Manufacturer
Requirements Must
Always Be Met!!!!!!



Two Types of Explosions

- Boiler – sudden breaking of the boiler pressure parts
- Furnace – sudden ignition of large quantities of fuel in the chamber

A Look at Pressure and Temperature Effects

- A 4' by 4' plate at 2 psi contains 2.3 tons of total force
- Residential 30 gallon hot water tank at 90 psig has 3,138,400 ft-lbs of energy to flash its water into steam at 330⁰ F. This represents about 1 ½ pounds of Nitroglycerin.

Inspection Authority



Local City or Town
Representative



Department of Administrative
Services – Division of
Construction Services - Office
of State Building Inspector –
Bureau of Boilers

Local Inspectors



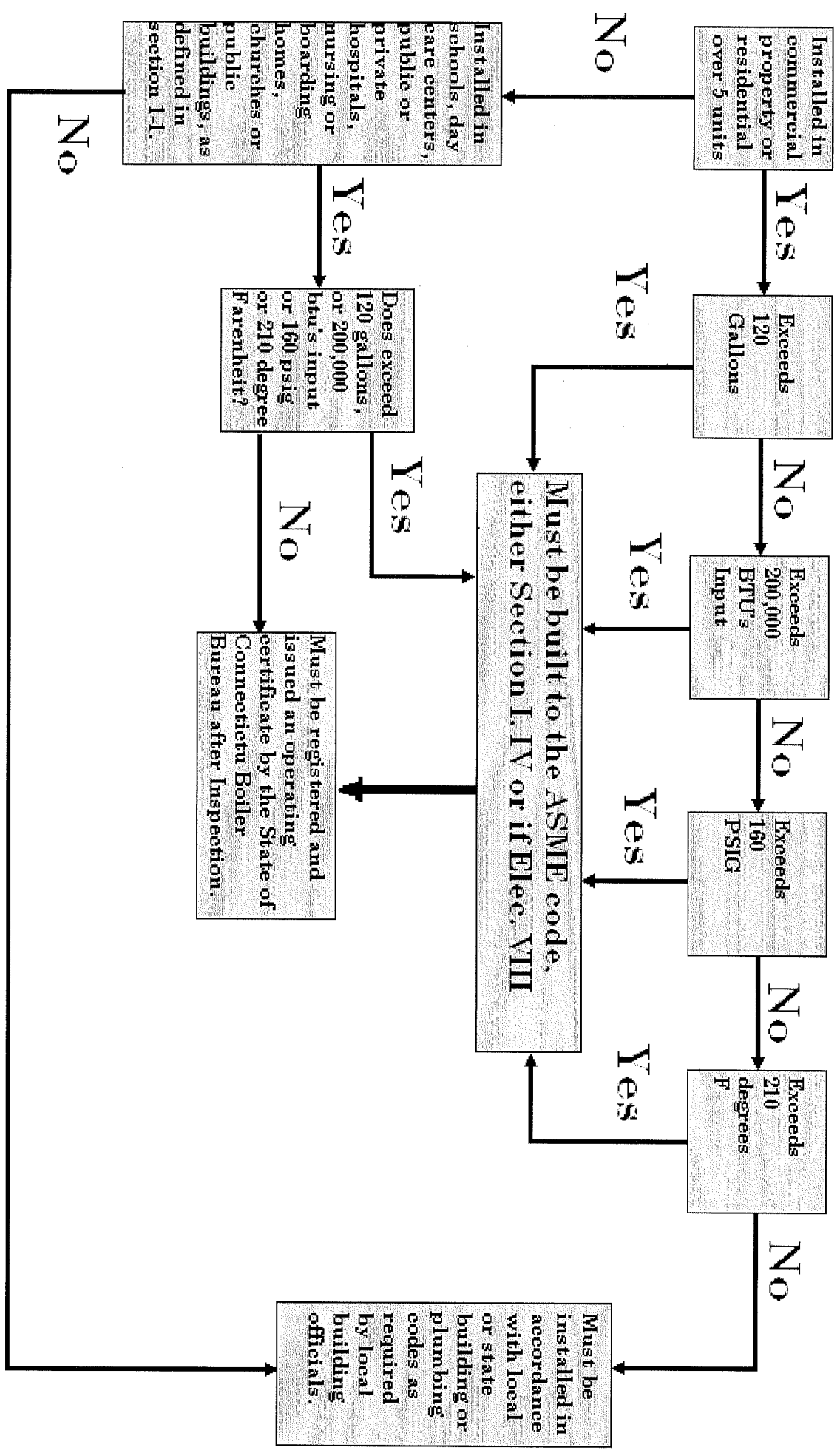
Everywhere

State of CT Bureau of Boilers

All Steam and Hot Water Boilers not excluded Chapter 540

The provisions of this chapter shall not apply to:

- (1) Federal control
- (2) Portable Boilers used in open field
- (3) portable boilers agricultural purposes
- (4) private homes or apartment houses of not more than five families
- (5) hot water heaters (see chart)
- (6) antique or model
- (7) public service companies, as defined in section 16-1.



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Construction Documents (IMC 106.3.1)

- 2 or more sets for each permit
- Registered design professional
- Drawn to scale and show compliance with this code
- More than 2 stories shall show penetrations, materials and methods for maintaining
- Exception – waive if review of plans for the work is not necessary to prove compliance

General Regulations

IMC Chapter 3

- Labels - shall be affixed with the appropriate information
- Manufacturing installation instructions shall be available at the job site
- Clearances – Passageways shall be ≥ 36 " wide and ≥ 80 " high
- Load Calculations – shall be determined in accordance *ASHRAE Handbook of Fundamentals*

Ventilation

IMC Chapter 4

- Minimum of 10' from lot lines or buildings. If front on a street line is measured from centerline
- Gravity – shall be 10' from any hazardous or noxious. If within 10' then located a minimum of 2' below the source.
- Outdoor exhaust and intake shall be protected. Openings in grilles and screens shall be sized in accordance with table 401.6

Combustion Air

IMC Chapter 7

- 1996 NFPA 54 Fuel Gas Code
- Chapter 7 for all non-gas fired
- IMC 709.2 – Dampered openings shall be interlocked with the firing cycle. Manually operated openings shall not be installed.
- Location and protection of openings shall comply with 401.5 and 401.6

**Manufacturer
Requirements Must
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Chimneys and Vents

IMC Chapter 8

- Masonry chimneys shall be lined.
- Connectors

Shall not be smaller than
flue collar

Clearance – oil fired $\geq 18''$

Pitch – $\frac{1}{4}$ " vertical



Chapter 10

Section 1001

- Shall Govern

Exceptions

- Unheated
- Portable
- Bulk O² & Medical
- < 5 Ft³ & < 250 PSI
- Refrigeration
- Used in conjunction
- Any boiler or pressure vessel subject to inspection by Federal or State

Boiler Standards

IMC 1004

- Oil Fired – UL 726
- Electric – UL 834
- Shall be designed and constructed in accordance with ASME CSD-1, the ASME *Boiler and Pressure Vessel Code*, Section I, II, V and IX, NFPA 8501, 8502 or 8504

Installation

- Operating Adjustments and Instructions –
- Shall be furnished by the installer
- Permanent type instructions shall be attached to the boiler
- Controls shall be set, adjusted and tested
- Data and the nameplate shall be attached

Clearances shall be maintained
– ***IMPORTANT – Servicing
and Inspection***

***MANY MANUFACTURERS
REQUIRE GREATER
CLEARANCES WHICH MUST
BE FOLLOWED***

Sometimes these are
recommendations and we do
not enforce recommendations

**Manufacturer
Requirements Must
Always Be Met!!!!!!**

Boiler Connections

IMC 1005

- Every boiler or modular boiler shall have a shutoff valve in the supply and return. For multiple boiler installs each shall have these valves.

Exception – system having a single low-pressure steam boiler

- Potable water supply shall be connected in accordance with IPC.

Safety and Pressure Relief Valves IMC 1006

- Boilers and pressure vessels shall be protected
- Shall be directly installed
- No Valves located on either side
- Discharge must be by gravity
Of Rigid pipe
No hazard potential
Same diameter of outlet
High Pressure – outside

Safety Devices & Elec

IMC 1006

- **Manufacturers requirements must be met!!!**
- CSD-1 Compliance
- Electrical shall be from a 2 wire branch that is grounded.
- Manual disconnect shall be provided

LWCO & Blowoff

IMC 1007 & 1008

- All shall be protected with a low-water cutoff control which shall automatically stop the combustion operation
- Blowoff valve shall be installed of the quick opening type with size as specified by manufacturer or the opening
- Shall discharge to a safe place and conform to IPC

Expansion Tank

IMC 1009

- All hot water systems shall have one or more expansion tank
- Tanks can be of either close or open type
- Shall be rated for pressure of the water system
- Closed types installed per manufacturer's instructions and properly sized
- Open shall be $\geq 4'$ above highest

Gauges

IMC 1010

- Hot Water – have a pressure and temperature gauge or combination.
- Shall indicate temperature and pressure within normal operation
- Steam – have a water-gauge glass and pressure gauge
- Gauge shall indicate pressure within normal operation
- Gauge glass – midpoint is at normal boiler water level

Tests

IMC 1011

- Acceptance tests shall be conducted

ASME Boiler and Pressure Vessel Code

- Test gauge shall be connected directly to the boiler
- Gauge must be $\geq 1 \frac{1}{2}$ times and ≤ 4 times the max test pressure

**Manufacturer
Requirements Must
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Hydronic Piping

IMC Chapter 12

- Pipe fittings shall comply with table 1202.5
- Valves shall be compatible with piping and rated for temp and pressure
- Joints and connections shall be of the approved type and shall be tight for the pressure of system
- Different piping materials shall use approved adapter fittings

- Pipe insulation shall -----
- Comply with IMC and 2009 IECC
- Replacement of boiler only
new piping to be insulated
to 2009 IECC
- Valves
- Heat Exchangers shall have
supply and return valves
- Pressure vessels shall have
shutoffs on connections to
- Reducing valves shall have
valve on both sides
- Shutoffs to equipment and
appliances
- Expansion tank if of the non
diaphragm type

- Piping Installation

Fluid in the supply side of a hydronic system shall not enter a tee fitting through branch line

Installed so system can be drained

Potable Water – IPC
backflow protected

>250 degrees – 1 inch
clearance from
combustibles






Pitch for steam must be
installed to drain to boiler or
trap

Misc Items to Inspect

- Chimney and Flue
- Fuel supply including tanks etc
- Specific electrical requirements
- Burner install
- Fuel Gas specific requirements

**Manufacturer
Requirements Must
Always Be Met!!!!**

Additional State Requirements

-  ASME designed boilers must have a data sheet on site
-  Blowoff tank required for HP boilers where blowdowns enter a sanitary system (29-232-41)
-  Safety valve must be installed on the low pressure side of a pressure reducing valve
-  HP Boilers >500 sq-ft – must have 2 or more SV's
-  Must have 2 or more feed supply

- Supports – each HP boiler must be safely supported by masonry or structural strength and rigidity.
- There shall be no excessive vibration in either boiler or piping
- Ladders and runways at least 18” wide with 2 exits from runway on adjacent boilers
- Gage cocks must be installed on water column unless 2 water gages with independent connections are installed
- 2 LWCO's required



Steam boilers with stop valves greater than 2" pipe size shall be of the outside-screw-and-yoke rising spindle type



Each steam boiler with a manhole opening shall be fitted with 2 stop valves with an ample free blow drain between them



These valves shall consist preferably of one automatic non-return valve set next to the boiler and a second valve of the outside screw-and-yoke







Pressure gauges –

High Pressure Boilers shall have a gauge that is graduated to approximately double the safety valve setting but in no case less than $1 \frac{1}{2}$ times





Low Pressure Steam Boilers shall have gauge that reads 30 psi not to exceed 60 psi

Hot Water Heating Boilers shall have gauge that is $1 \frac{1}{2}$ times safety valve setting not to exceed $3 \frac{1}{2}$ times

-  Gravity return steam heating systems must have the “water line return” arrangement!
-  Each automatically fired steam boiler shall be protected with 2 pressure controls
-  The highest must be equipped with a manual reset
-  Manifold of the controls is allowed but must meet CSD-1 Requirements

- A high temperature control with manual reset (CSD-1, Boiler Regulation 29-232-99)
- Low-Water Cut Off not required on Hot Water Boilers with input of 400,000 btu's or less
- Safety valves – installed in vertical position. Discharge pipe is not required but is recommended

Remote Shutdown

-  A manually operated remote shutdown switch or circuit breaker shall be located
-  CSD-1 and boiler regulations are not fuel specific
-  If there is more than one door then must be one at each door
-  If fear of tampering – then can place inside the door

**Manufacturer
Requirements Must
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THE END